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**HOW DOES
WESTERN SPRUCE BUDWORM
FEEDING AFFECT WESTERN LARCH?**

David G. Fellin and Wyman C. Schmidt



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We gratefully acknowledge the assistance of the Lolo National Forest for making the study area available.

FRONT COVER PHOTO: A western spruce budworm larva is emerging from a tunnel in the terminal shoot of a young larch. This tunneling has cut conducting tissues, causing the shoot to wilt and droop.

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ABSTRACT

This pictorial describes how western spruce budworm larvae feed on young western larch and the trees' responses to this damage. Larvae feed not only on the current year's foliage—their usual diet on most coniferous hosts—but also sever stems of current year's shoots. Multiple-topped, bushlike trees develop in direct response to the amount and type of damage. As a result, trees cannot maintain straight boles and good form. Sustained budworm damage could conceivably influence the management of western larch—one of the more important conifers in the northern Rockies.

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WHAT IS THE PROBLEM?

Damaged and deformed western larch¹ are increasingly apparent in young coniferous forests of the northern Rockies. Land managers are asking: (1) What is the cause? and (2) What is the effect? The first question is answered simply—western spruce budworm larvae sever stems of current-year shoots of larch.

The effect is discussed in this paper, which includes (a) a brief review of budworm infestations leading to the present problem; (b) pictorial examples of larval damage to the trees and the trees' responses to the damage; and (c) a discussion of the implications for the resource manager.

¹Common and scientific names of coniferous trees and insects mentioned in this Report are found on page 23.

HOW DID THE PROBLEM DEVELOP?

Budworm was recognized in the early 1920's as a serious forest pest in northern Rocky Mountain coniferous forests, when outbreaks were recorded in Idaho and in Yellowstone National Park, Wyoming. At that time, budworm larvae were observed feeding on a variety of coniferous trees including grand fir, Douglas-fir, Engelmann spruce, western larch, western hemlock, western white pine, ponderosa pine, lodgepole pine, and western redcedar.

Budworm larvae have also been found feeding on staminate flowers and pistillate cones of some of these hosts.



On most of these host trees, western spruce budworm larvae fed on the current year's foliage as illustrated by this typical defoliation on a Douglas-fir limb.

Between 1922 and the mid-1940's, most western budworm outbreaks were relatively small, localized, and short-lived. In the late 1940's, widespread outbreaks developed in western Montana; by 1958, the budworm had infested nearly 6 million acres in Idaho and Montana, primarily in southwestern Montana, where the principal host was Douglas-fir. Budworm activity in these forests decreased in the early 1960's, especially east of the Continental Divide; by 1969, the infestations were very patchy and scattered.

Concurrently, the budworm infested forests in extreme west-central and northwestern Montana and adjacent forests in north-central Idaho. By 1969, over 4 million acres of coniferous forest were infested—1.3 million acres in Idaho and 2.7 in Montana. As the budworm developed in these areas, it invaded the range of host tree species, including western larch, on which it had not been troublesome since the outbreaks of the 1920's.



Western larch characteristically grows rapidly and straight. The good form of this tree—specifically, the straight bole and absence of upturned laterals—is typical of young larch in western Montana that have not been seriously damaged by the western spruce budworm.

HOW DO BUDWORM FEED ON LARCH?

On western larch, spruce budworm larvae not only feed on the foliage, in much the same way as on other hosts, but they also sever the stems of new shoots—a peculiar feeding behavior observed only recently.

Many needles have been eaten off these new larch shoots, particularly the shoot on the right. There is no noticeable damage to the stem or to vegetative buds on the ends of the shoots.





A larva has consumed most of the foliage and has also chewed the stem of this shoot. The feeding did not sever the shoot, but was extensive enough to deform it. Damaged but unconsumed needles, webbing, frass, and debris are visible in the feeding area.



Stem feeding sometimes is more localized than that shown on page 6. When this occurs, a larva may chew halfway through a stem, or farther. Although the stem might not be severed, damage is extensive enough to cut the conducting tissues.



When conducting tissues are cut, usually in mid and late June or early July, the shoot wilts and droops. The arrow in this photo indicates the location of the chewing illustrated in the photo on page 7.

Some larvae begin feeding on the stem; after chewing part way through, they begin to tunnel longitudinally within the stem near the chewed section.

A western spruce budworm larva is emerging from a tunnel in a stem (part of the webbing, frass, and debris were removed to show damage). Such tunneling cuts conducting tissues, causing the shoot to wilt and droop, as shown on page 8. As a result, the distal portion of the shoot dies and falls off or is blown away.



Stem feeding, whether it be mining or external chewing, is usually so severe that shoots are severed.



Larvae severed this terminal leader, as well as most laterals.

Although they consume a few needles near the feeding site on the stem, budworm larvae in most cases chew on stems of terminal or lateral shoots and feed little or not at all on foliage elsewhere on the tree.

Reports from the early 1920's, when the western spruce budworm was first discovered in northern Idaho, indicate that entire limbs of western larch, as well as western hemlock and other species, were defoliated.



In this 1922 photograph of a young larch (Priest Lake area, Idaho), all of the needles on nearly every fascicle have been chewed off. Of greater significance, the leader was severed about midway from the branch whorl to the tip, and stems of several lateral shoots show signs of having been fed on or severed.

HOW DOES LARCH RESPOND TO BUDWORM FEEDING?

When a terminal shoot is severed, lateral shoots turn up to replace it as a leader. This demonstrates the strong apical dominance of western larch. Generally, the magnitude of such a response is directly related to the severity of the damage. Frequently, when a terminal shoot is cut off, neither the foliage nor stems of the upper laterals are damaged.



Here, both upturned laterals seek apical dominance and vie for the terminal position.

After a leader is severed, a forked tree develops if two laterals are equally successful in competing for the terminal position and neither lateral is cut in succeeding years.

This forked tree was photographed at the end of the 1968 growing season. The leader of the tree was cut in 1966 (arrow) and two lateral shoots developed into leaders. Neither leader was severed by budworm in 1967 or 1968.



Dichotomous leaders usually develop when terminal shoots of forked trees are cut in subsequent years.



When photographed at the end of the 1968 growing season, this badly deformed tree had several distinct shoots vying for the terminal position. This resulted from severance of the main stem in 1962 (lowest arrow), of the right fork in 1965 and 1967 (curved arrows) and 1968 (highest arrow), and of the left fork in 1966 (open arrow).

Bushlike trees develop as a result of repeated severance of the terminal and upper lateral shoots. Regardless of which shoot eventually dominates, bole deformities—perhaps only temporary—can be expected.

Nearly a dozen shoots are contending for the terminal position on this bushlike tree.



The leader and upper lateral shoots often are damaged so extensively that no lateral shoots remain to compete for the terminal position. As a result, there is extreme proliferation of shoots the following growing season. If the incidence of severances is high again during the next year, branching becomes even more profuse.



Western spruce budworm larvae severed the terminal and all laterals in the upper crown of this tree.

A terminal sometimes fails to achieve dominance even when no damage occurs the following year.

Although many shoots were produced in 1968, when this tree was photographed, none of the shoots were severed and none appeared to have a competitive advantage. This profusion of shoots developed after the leader and most of the upper lateral shoots of the tree were cut in 1965, 1966, and 1967.



Budworm larvae occasionally sever the terminal and most of the upper lateral shoots; this reduces potential forking and allows the surviving laterals a competitive advantage for the terminal position.

Budworm larvae severed the terminal and all but one of the upper laterals of this tree. As a result, no fork developed; this permitted the upturned lateral to assume a vertical position and become a single terminal leader the following growing season.



A single terminal leader that develops from an upturned lateral can maintain a dominant terminal position as long as it is not cut off.

The terminal and all but one lateral shoot were severed on this tree in 1964. The new terminal was not severed during the next three growing seasons. When this photograph was taken in late summer of 1968, the new terminal was still the dominant shoot. However, the main stem still had a definite crook and some laterals still tended to turn up.



Although some bole deformities may persist, most disappear within a few years.

If the terminal is cut, tree form is affected more significantly and bole deformities persist for a longer period.



The crook in this stem developed after a larva fed externally on, but did not sever, the stem. The crook was still prominent when it was photographed the year following the damage, but the outward signs of feeding (arrow) were barely visible.

The leader of this tree was severed in 1964 resulting in a dual terminal. One of the shoots was eventually suppressed but the crook in the main stem still persisted when this photograph was taken in 1968. Terminal severances in 1965, 1967, and 1968 produced additional crooks in the bole resulting in this misshapen tree. The minor deformities in two of the three uppermost 1968 shoots were caused by larvae chewing externally on the stems.



We wish to emphasize that in many western Montana forests this type of budworm damage has developed only recently in young larch.

When this tree was photographed in 1968, it was 14 years old. The straight bole and absence of upturned laterals show that the tree was not damaged during its first 11 years. The multiple-topped, lyre-shaped, upper crown is a result of damage during 1966, 1967, and 1968, when the leaders and 75 percent of the upper laterals were severed by budworm larvae.



WHAT ARE THE IMPLICATIONS FOR THE RESOURCE MANAGER?

Western larch is one of the most important conifers in the northern Rockies, and sustained budworm damage to this species could conceivably influence its management. Feeding by larvae of the western spruce budworm jeopardizes rapid juvenile height growth and excellent form—two highly desirable characteristics of western larch.

Our study showed that net height growth was reduced 25 to 30 percent when terminal leaders were cut by budworm larvae. It also showed that as western spruce budworm infestations built up in our study area, the incidence of multiple-topped trees increased and trees were less able to outgrow forks. We also found that budworm damage is present on seedlings, saplings, and pole-size trees in any area of western Montana where distributions of western spruce budworm and western larch coincide.

The quantitative aspects of our study were reported in the *Canadian Journal of Forest Research*, Vol. 3, 1973 "Western spruce budworm damage affects form and height growth of western larch." We are publishing this pictorial as an added aid for resource managers. Studies are continuing to determine the long range impact of budworm damage to young larch in western Montana.

COMMON AND SCIENTIFIC NAMES OF CONIFEROUS TREES AND INSECTS

TREES

Western larch	<i>Larix occidentalis</i> Nutt.
Grand fir	<i>Abies grandis</i> (Dougl.) Lindl.
Douglas-fir	<i>Pseudotsuga menziesii</i> var. <i>glauca</i> Beissn. Franco.
Engelmann spruce	<i>Picea engelmannii</i> Parry
Western hemlock	<i>Tsuga Heterophylla</i> (Raf.) Sarg.
Western white pine	<i>Pinus monticola</i> Dougl.
Ponderosa pine	<i>Pinus ponderosa</i> Laws.
Lodgepole pine	<i>Pinus contorta</i> Dougl.
Western redcedar	<i>Thuja plicata</i> Donn

INSECTS

Western spruce budworm	<i>Choristoneura occidentalis</i> Freeman
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For some time, there have been indications that several races or varieties of the spruce budworm, *Choristoneura fumiferana* (Clem.) exist in the Western United States. Four new species of *Choristoneura* in western North America were recently described. The most widespread of these and the one discussed in this Report is known as the western spruce budworm, *C. occidentalis* Freeman.

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Photo on back cover shows a vigorous young western larch stand developing on a clearcut in a scenic mountain setting.

